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OFFICE OF CHEMICAL SAFETY AND POLLUTION PREVENTION

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MEMORANDUM

Subject: Addendum to 2,4-D Choline Salt Section 3 Risk Assessment: Refined Endangered Species Assessment for Proposed New Uses on Herbicide-Tolerant Corn and Soybean

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The Environmental Fate and Effects Division (EFED) performed a screening level risk assessment for a proposed Federal action involving proposed new uses of 2,4-D choline salt on herbicide-tolerant corn and soybean on January 15, 2013 (DP 400223, 400230, 400234, 400237, 405028, 405812); an amendment to the assessment was issued on June 13, 2013 (DP 411614). Overall, the assessment determined that direct risk concerns were unlikely for birds (chronic), aquatic plants (vascular and non-vascular), freshwater fish (acute and chronic), estuarine/marine fish (acute and chronic), freshwater invertebrates (acute and chronic), estuarine/marine invertebrates (acute and chronic), and terrestrial insects. Potential direct risk concerns could not

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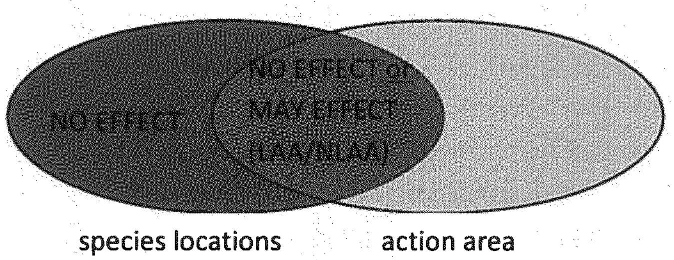
be excluded for mammals (acute and chronic); birds, reptiles, and terrestrial-phase amphibians (acute); and terrestrial plants. Indirect effect risk concerns for all taxa were possible for any species that have dependencies (e.g., food, shelter, habitat) on mammals, birds, reptiles, terrestrial-phase amphibians, or terrestrial plants. Based on EFED's LOCATES database and information independently supplied by DOW AgroSciences, LLC, 53 species in the 6 states proposed for registration (Illinois, Indiana, Iowa, Ohio, South Dakota, and Wisconsin) were identified as within the action area (at a preliminary county-wide level of resolution) associated with the new herbicide-tolerant corn and soybean uses.

EFED has refined the endangered species risk assessment on the basis of spray drift mitigation language that has been added to the label. Specifically, the spray drift language limits applications to the AIXR 11004 nozzle and the GF2726 tank mix formulation. It requires the use of a 60 ft on-field buffer when the wind is blowing towards all areas that are not fields in crop cultivation, paved areas, or areas covered by buildings and other structures. Species specific biology, and 2,4-D choline salt application timing information are also incorporated into the refined endangered species assessment. The following text discusses the lines of evidence and processes that were used to make effects determinations for listed species identified as potentially at-risk in the screening level assessment.

Making an Effects Determination

The bullets below outline EFED's process for making an effects determination for the Federal action:

- For listed individuals inside the action area but **NOT** part of an affected taxa **NOR** relying on the affected taxa for services (involving food, shelter, biological mediated resources necessary for survival/reproduction), use of a pesticide would be determined to have NO EFFECT.
- For listed individuals outside the action area, use of a pesticide would be determined to fall under NO EFFECT.
- Listed individuals inside the action area may either fall into the NO EFFECT or MAY EFFECT (LIKELY or NOT LIKELY TO ADVERSELY AFFECT) categories depending upon their specific biological needs, circumstances of exposure, etc.



- LIKELY or NOT LIKELY TO ADVERSELY AFFECT determinations are made using the following criteria:
  - Insignificant - The level of the effect cannot be meaningfully related to a "take."
  - Highly Uncertain - The effect is highly unlikely to occur.
  - Wholly beneficial - The effects are <u>only</u> good things.

<u>Spray Drift Mitigation</u>

Fifty-three listed species (4 insects, 4 mammals, 19 molluscs, 1 reptile, 12 dicots, 4 monocots, 1 crustacean, 5 birds, and 3 fish) were identified as potentially at risk (direct or indirect effects) in the six states as a result of the screening-level assessment (Appendix 1). The spray drift mitigation language is intended to limit off site transport of 2,4-D choline in spray drift to the extent that no off site area that could potentially provide non-target organism habitat will receive loadings that will trigger concerns for any terrestrial receptor class assessed in the risk assessment (terrestrial vertebrate, invertebrate, or plants). The assessment assumes that spray drift will remain confined to the field and that the action area is limited to the 2,4-D choline treated field. Terrestrial species that are not expected to occur on treated fields under the provisions of the proposed label are not expected to be directly exposed to 2,4-D choline, nor are their critical biologically mediated resources expected to be exposed to levels of the herbicide above any acute or chronic thresholds of concern. [Note: the risk assessment has concluded no aquatic receptor taxa to be of concern.] Consequently, 49 of the 53 species originally identified as potentially at-risk can be given a "no effect" determination based on the premise that they are not expected to occur on corn and soybean fields (Appendix 2).

The spray drift mitigation label language cannot preclude listed species exposure <u>on</u> treated fields, should a listed species utilize such areas as part of its range. Of the listed species within the six states (IL, IN, IA, OH, SD, WI) considered part of the proposed Federal decision, the Canada lynx (*Lynx canadensis*), whooping crane (*Grus americana*), American burying beetle (*Nicrophorus americanus*), and Indiana bat (*Myotis sodalis*) are reasonably expected to occur on treated corn and soybean fields. Therefore, species specific biological information and 2,4-D choline salt use patterns were considered in more depth to refine the assessment.

<u>Canada Lynx</u>

The screening-level risk assessment suggests that mammals of lynx size or greater could be at reproductive risk should exposures occur. Further consideration of the biology, specifically habitat use of the lynx in the contiguous United States, was undertaken to determine if it is reasonable to expect that exposures would occur.

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The United States Fish and Wildlife service describes Canada lynx habitat in the Federal Register Notice: September 25, 2013 Revised Designation of Critical Habitat for the Contiguous U.S. Distinct Population Segment of the Canada Lynx and Revised Distinct Population Segment Boundary (http://www.fws.gov/mountainprairie/species/mammals/lynx/09112013LynxTempFR.pdf). According to the habitat summary, the Canada lynx is a highly specialized predator of snowshoe hares and is dependent on landscapes with high-density snowshoe hare populations for survival and reproduction. Lynx and snowshoe hares are strongly associated with what is broadly described as boreal forest. Lynx habitat can generally be described as moist boreal forests that have cold, snowy winters and a snowshoe hare prey base. The boreal forests that lynx use in the contiguous United States are characterized by patchily-distributed moist forest types with high hare densities in a matrix of other habitats (e.g., hardwoods, dry forest, non-forest) with low landscape hare densities. In these areas, lynx incorporate the matrix habitat (non-boreal forest habitat elements) into their home ranges and use it for traveling between patches of boreal forest that support high hare densities where most lynx foraging occurs.

In light of the expected reliance on boreal habitat for foraging and the absence of this habitat on 2,4-D treated corn and soybean fields, it is not reasonable to expect that the Canada lynx will be exposed to 2,4-D choline residues in small mammals (prey) from treated corn and soybean fields. **It is therefore reasonable to conclude a "no effect" for this species under prescribed conditions of the use of 2,4-D choline under this Federal action.**

<u>Whooping Crane</u>

Whooping cranes migrate from Texas to Canada from March 25th to May 1st. During migration, a crane will stop to eat and may consume arthropod prey. EFED considered the maximum T-REX predicted concentrations of 2,4-D choline salt expected to be found on arthropods as a conservative pesticide load in the prey base. Alternative terrestrial vertebrate prey are expected to have lower residues than those predicted for arthropods. A biologically representative modification to the screening assessment follows:

Field metabolic rate kcal/day = $1.146(5826)^{0.749} = 757.6$ kcal/day (USEPA 1993, body weight Dunning 1984)
Mass of prey consumed per day = 757.6 kcal/day/(1.7 kcal/gX0.72 AE) = 619 g/day
Mass of 2,4-D choline in insect diet 226.56 mg/kg-ww from T-REX run
Mass of 2,4-D in daily diet mg = 619 g/day X 226.56 mg 2,4-D/kg mammal prey X 0.001 = 140.2 mg/day
Daily dose in crane = 140.2 mg 2,4-D/day/5.826 kg = **24.07 mg/kg-bw/day**

Scaling the acute toxicity endpoint by bodyweight (per T-REX methodology), the acute oral toxicity value for the crane is:

Crane LD50 mg/kg-bw = 218.7 mg/kg-bw $(5826/178)^{(1.15-1)}$ = **369.05 mg/kg-bw**
RQ for daily acute exposure for three applications, peak exposure number: RQ = 24.07/369.05 = **0.065.**

An RQ of 0.065 does not exceed the LOC of 0.1; **consequently a "no effect" determination is concluded for the whooping crane.**

American Burying Beetle

Habitat use and dependencies were explored to determine if any effects on plants would indirectly affect the burying beetle. Except where noted, the information was sourced from the Recovery Plan for the species (USFWS 1991). The American burying beetle is a carnivorous species. Adults feed on a variety of carrion as well as live insects. The larvae are reared on cached (buried) carrion. Consequently, any effect of 2,4-D choline would be mediated through the availability of vegetative cover for the species because direct toxic effects are not expected, and plants do not constitute a necessary food component. Out of the six states of interest, the American burying beetle is only known in South Dakota. Variable habitat and wide soil types make its habitat difficult to describe in anything other than broad terms.

The species exhibits broad vegetation tolerances (from large mowed and grazed fields to dense shrub thickets), though natural habitat may be mature forests. The species has been recorded in grassland, old field shrubland, and hardwood forests. For example the Block Island population (Rhode Island) occurs on glacial moraine dominated by maritime scrub-shrub community. Plant species include bayberry, shadbush, goldenrod, and various non-native plants. Oklahoma habitats vary from deciduous oak-hickory and coniferous forests atop ridges or hillsides to deciduous riparian corridors and pasturelands on valley floors.

There are no direct toxicological effects to the burying beetle. The only likely indirect effect could be a reduction in cover provided by plants. The Recovery Plan (USFWS 1991) indicates that vegetative structure and soil types are unlikely to be limiting factors for the burying beetle given its broad historical geographic range. Furthermore, the apparent persistence of the beetle on Block Island suggests broad vegetation (landscape) tolerances. Given that applications of 2,4-D choline salt will leave the crop intact, the field is expected to maintain sufficient vegetative cover for the burying beetle. **Consequently, a "no effect" determination is concluded for the American burying beetle.**

Indiana Bat

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Initial screening level risk assessment results for the Indiana bat were adjusted to account for the bat's biology.

Field metabolic rate kcal/day = $0.6167(5.4)^{0.862}$= 2.64 kcal/day (USEPA 1993, body weight reflects screening assumption for the Indiana bat)
Mass of prey consumed per day = 2.64 kcal/day /(1.7 kcal/g ww X 0.87AE)= 1.78 g/day
Mass of 2,4-D choline in insect diet 226.56 mg/kg-ww from T-REX run
Mass of 2,4-D in daily diet = 1.78 g/day X 226.56 mg 2,4-D/kg-ww mammal prey X 0.001 = 0.40 mg/day
Daily dose in bat = 0.40mg 2,4-D/day/0.0054 = **74 mg/kg-bw/day**

A daily dose of 74 mg/kg-bw/day places the daily exposure of the bat is above the two-generation reproduction study (rat), NOEL of 5 mg/kg-by/day used in the screening risk assessment, even when scaled. Consequently, a "no effect" determination cannot be concluded for the Indiana bat using just the lines of evidence found in the screening level risk assessment screening level risk methods. However, this screening assessment incorporates a variety of conservative assumptions in that it assumes all bats weigh the same and that all bats eat their entire daily diet sourced from a treated field, and that pesticide residues are at a fixed and stable level. EFED explored the roles of various assumptions of bat biology and habitat use to evaluate the likelihood of exceeding the toxic thresholds for growth and survival of offspring in laboratory reproduction testing.

Indiana Bat Biology and Habitat Characteristics

The chance of an individual bat coming into contact with a 2,4-D choline use site is not discountable on the basis of bat numbers, patterns of dispersal, temporal overlap with likely pesticide use, and likely resource use within the vicinity of treated areas. Consequently, EFED investigated various bat biological and habitat characteristics to better characterize the risk, if any, the proposed Federal action poses to this species.

Indiana bats travel a variety of distances between their hibernation sites and their summer homes. They can migrate hundreds of kilometers from their hibernacula to summer roosts. The bats use their summer foraging/maternity roosting site for more than half of the year with maternity colony formation and young production to flight ranging from mid-May through August. This period of habitat use overlaps with 2,4-D choline use based on information on planting dates and crop stage information (Appendix 3) that suggest 2,4-D choline use, in accordance with the proposed label, can occur in a window between April and June for pre-emergence and post-emergence periods (corn reaches a "V8" growth stage from May through August; soybean reaches the "R2" growth stage from June through August).

The USFWS Recovery Plan (USFWS 2007) states that most Indiana bat maternity colonies have been found in agricultural areas with fragmented forests. According to the Recovery Plan there are some 235,000 individual bats within the hibernacula of the sates subject to the proposed Federal action. The Recovery Plan also indicates that the sex ratio of males to females is roughly equal. Therefore, there are approximately 117, 500 female bats within the hibernacula that are found in the states in this proposed Federal action.

While bats may be associated with forested areas proximal to agricultural land, the data on the extent and possibility of foraging over agricultural fields is limited. The Recovery Plan states that observations of light-tagged animals and bats marked with reflective bands indicate that Indiana bats typically forage in closed to semi-open forested habitats and forest edges and that radio-tracking studies of adult males, adult females, and juveniles consistently indicate that foraging occurs preferentially in wooded areas, although type of forest varies with individual studies. The Recovery Plan states that Indiana bats hunt primarily around, not within, the canopy of trees, but they occasionally descend to sub-canopy and shrub layers. However, the Recovery Plan also states that Indiana bats have been caught, observed, and radio-tracked foraging in open habitats; analyses of habitats used by radio-tracked adult females while foraging versus those habitats available for foraging have been performed in two states.

In Illinois, floodplain forest was the most preferred habitat, followed by ponds, old fields, row crops, upland woods, and pastures. In Indiana, woodlands were used more often than areas of agriculture, low-density residential housing, and open water, and this latter group of habitats was used more than pastures, parkland, and heavily urbanized sites. Old fields and agricultural areas seemed important in both studies, but bats likely were foraging most often along forest-field edges, rather than in the interior of fields, although errors inherent in determining the position of a rapidly moving animal through telemetry made it impossible to verify this. The Recovery Plan remarks that visual observations suggest that foraging over open fields or bodies of water, more than 50 m (150 ft) from a forest edge, does occur, although less commonly than in forested sites or along edges. The Recovery Plan places feeding within agriculturally managed areas of lesser significance than forested areas and their immediate edges.

The Recovery Plan reports that in Illinois, 67 percent of the land near one colony was agricultural, and in Michigan, land cover consisted of 55 percent agricultural land. Recovery Plan discussion of available proportions of different land covers encompassing foraging habitat are limited, but the available literature suggests that foraging in agricultural lands relative to other habitats is variable with study. Sparks et al. (2005), in radio-tracking bats in Indiana, found that the number of telemetry observations of foraging was closely associated with the availability of agricultural land within the home range of the species and accounted for approximately 35 percent of observations. In contrast, Murray and Kurta (2004) radio-tracked Indiana bats in Michigan and found that, despite the study area being over 60 percent agricultural land, the

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habitats frequented by 12 of the 13 monitored bats was forest land. It should be noted that exact frequencies could not be established because triangulation of individual observation points precluded exact locations in different cover types with any confidence. Menzel et al. (2005) radio-tracked bats in Illinois and found that bats foraged significantly closer to forest roads and riparian habitats than agricultural lands. A ranking of the foraging use of habitats suggested the following order of preference by bats in this study: roads> forests> riparian areas> grasslands>agricultural lands.

The Recovery Plan indicates that the prey base for the Indiana bat consists primarily of flying insects, with only a very small amount of spiders (presumably ballooning individuals) included in the diet. Four orders of insects contribute most to the diet: Coleoptera, Diptera, Lepidoptera, and Trichoptera. The Recovery Plan concludes that the diet of Indiana bats, to a large degree, may reflect availability of preferred types of insects within the foraging areas that the bats happen to be using, again suggesting that they are selective opportunists.

With respect to the ability for agriculture areas being capable of providing some element of prey base to the bat, the Agency has reviewed insect census data on corn for other regulatory purposes and has established that a variety of beneficial and pest insect species are present in fields crops such as corn. For example the Agency (USEPA 2010) review of submitted data to support the registration for biopesticides includes the following results of a field insect census of corn:

Sample Method	Insect Order (Family)
Soil and Root Samples (soil dwelling invertebrates)	Diplura (Japygidae), Chilopoda, Aranea, Acari, Oligocaeta Coleoptera (Carabidae, Staphylinidae, Nitidulidae, Lanthridiidae), Hymenoptera (Formicidae)
Pitfall Trap Samples (gound/plant invertebrates)	Orthoptera (Gryllidae), Coleoptera (Carabidae, Scarabeidae, Chrysomelidae), Staphylinidae, Nitidulidae, Hymenoptera (Formicidae), Araneae, Chilopoda
Yellow Sticky Trap Samples (flying/plant invertebrates)	Coleoptera (Chrysomelidae, Nitidulidae, Coccinellidae), Hymenoptera, Homoptera (Aphididae, Cicadellidae), Hemiptera (Anthocoridae), Diptera (Syrphidae), Neuroptera (Chrysopidae, Hemerobiidae), Aranea

Among the three sample methods (soil, pitfall, and sticky trap), there was a total of 156,572 organisms from 16 orders and 36 families identified during the 2000 and 2001 growing seasons. Collected invertebrates included pests, predators, parasitoids, detritivores, and decomposers.

This information suggests that there are a variety of flying insects that could constitute some element of the prey base for bats foraging over agriculture fields.

Given the above information, it is reasonable to conclude that Indiana bats make use of agricultural land as a source of prey and can reasonably be expected to roost in patches of fragmented forest that are adjacent to corn and soybean fields. They are opportunistic foragers and are expected to forage over many different land covers, including agricultural land, on a broad range of insects/arthropods. A survey of corn insect populations reveals a variety of flying, foliage and ground dwelling invertebrates comprising a large number of taxonomic groups that could provide on-field prey sources for bats foraging over these areas. However, the extent of foraging over agricultural land is expected to be less than the degree of foraging around the canopies of forested areas.

Probabilistic Run for Indiana Bat

EFED explored how varying a number of assumptions used in the screening-level assessment could provide a more complete understanding of any risk posed to Indiana bats found feeding in and around 2,4-D choline treated crops. A Monte Carlo-based probabilistic assessment model, using Crystal Ball software (release 11.1.2.3.000) in an Excel, was used to 1) vary key modeling parameters and 2) count the number of exposure days post application where daily dietary exposures would exceed pertinent reproduction and growth toxicological endpoints established by available reproduction and developmental studies. The model:

1. Randomly assigned an insect residue level to prey base from an empirical distribution constructed from empirical pesticide residue studies;
2. Assigned residue decline functions to the insect residues to account for dissipation/degradation of the pesticide with time;
3. Randomly assigned a weight to each bat modeled and from that calculated energy requirements and corresponding daily insect consumption rates;
4. Randomly assigned a proportion of the daily diet likely to originate from areas over cropped fields;
5. Calculated the daily oral exposure of each bat; and
6. Compared this exposure to a toxicologically appropriate reproduction threshold, scaled to each modeled bat weight.

Under this model construct, a total of 117,500 individual female bats were modeled. This number of bats is reasoned to approximate the total number of females potentially exposed, based on the census data for hibernacula associated with the states subject to the proposed Federal action (235,000) and the roughly even sex ratio reported in the Recovery Plan.

Toxicological Endpoint Discussion

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The toxicological endpoints against which daily exposure estimates were compared in the screening assessment for the Indiana bat were derived from the multigenerational reproduction study (MRID 0015057) discussed earlier in the screening risk assessment. Animals were repeatedly exposed to 2,4-D acid over multiple generations. This study established a no effects level NOEL for pup growth at 5 mg/kg/day and a pup survival NOEL at 20 mg/kg/day. Higher doses (80 mg/kg/day) produced reduced pregnancies, and skeletal malformations and well as a reduction in the survival of pups in the F1b generation. Initial runs of the probabilistic exposure model suggested that bat exposures above such thresholds may only exceed thresholds for a few days. There is considerable uncertainty, in the absence of any further lines of evidence as to the toxicological significance of these short-term exposures predicted in the probabilistic model.

EFED considered other lines of evidence in evaluating this issue. These lines of evidence consist of the toxicological observations from the rat developmental toxicity study (MRIDs 00130407 and 47417902) and more recent rat reproduction data (MRID 47417901) that has been interpreted by the Office of Pesticide Program Health Effects Division (HED).

In the developmental study pregnant rats were orally gavaged with 2,4-D during gestation days 6 through 14. In evaluating this short-term study, EFED would consider the absence of effects in mothers or offspring at similar dose levels to the reproduction to constitute a line of evidence to suggest that the predicted short duration of exposures as indicated from the probabilistic model would be unlikely to produce adverse reproduction effects suggested by a comparison with endpoints from long term studies. If similar effects were seen for the developmental effects at similar doses as in the reproduction study, this would be considered a line of evidence that would give more confidence to a prediction that modeled short-term exposures were toxicologically significant. The referenced developmental study established a rat maternal toxicity NOEL of 25 mg/kg/day (based on reduced body weight gain and slight decrease in pregnancy rate) and an offspring NOEL of 75 mg/kg/day (based on ossification and alignment effects on vertebrae and sternebrae). The reproduction study observations of reduced pup weight were not observed in this study at any dose level and reduced survival was also not seen. However, the higher doses in the developmental study that produced skeletal malformations were also seen at similar doses in the rat two-generation reproduction study.

Consultation with HED (Taylor 2014) confirmed that effects such as the observed skeletal malformation seen in both the developmental and reproduction tests were likely the product of single short-term exposure events at significant times in development of offspring. However an additional line of evidence was introduced for consideration. This focused on pharmacokinetic information that relates pesticide intake to elimination rates. Under this hypothesis, it was proposed that renal mediation of internal levels of 2,4-D was responsible for the manifestation of toxic effects, such that when the capacity to eliminate 2,4-D from the body was exceeded, excess exposure was the cause for the observed effects. Since the NOEL and LOEL values for many of the effects seen in reproduction and developmental studies are separated by multifold differences in the relative doses, consideration of this clearance capacity phenomenon was considered as a possible route to a more mechanistically informed dose level corresponding to a threshold for adverse effects. HED reached the following conclusions for rat pharmacokinetic data, a dose range finding study for rat reproduction and the rat extended one generation reproduction data (MRIDs 47417901 and 47417902):

1. 2,4-D is well absorbed orally, undergoes limited metabolism, and is eliminated quickly from the body primarily unchanged in the urine by active saturable renal transport. The observed dose-dependent, non-linear pharmacokinetics of 2,4-D is primarily from the saturation of this renal secretory transport system. This saturation results in elevated plasma concentrations of 2,4-D that are associated with toxicity.

2. 55 mg/kg/day is the dose level where elimination is beginning to be overwhelmed; adverse effects occur only at dose levels that saturate excretion. Doses at and greater than 55 mg/kg/day are of concern.

The 55 mg/kg/day was considered to be a more refined estimate of the threshold for effects in the rat, taking into account the pharmacokinetics information. This endpoint, was scaled to individual modeled bat body weights using the extrapolation technique described in T-REX and these individual thresholds were used in the refined probabilistic risk assessment

Variables Distributed Within the Model

Bodyweight: EFED assumed a triangular distribution established on a reported body weight range of 5 to 11 g (Whitaker and Hamilton, 1998) and a mean of 8 g was selected because of the paucity of distributional information.

Residues in insects: EFED used a log normal distribution (mean = 65, SD = 48) from the extant report on the evaluation of available insect residue data to support TIM and T-REX. This distribution is normalized to 1 pound per acre application of an active ingredient. Therefore samples from this distribution are adjusted to the application rate of 2,4-D choline according to the proposed label and assuming a liner 1 for 1 relationship between residue and application rate in pounds. EFED considered information regarding flying insect residues cited in Dow AgroSciences Study No. 13126, in addition to the internal residue evaluation reports. However, much of the flying insect data cited in the Dow report was concluded to be sourced from background materials already considered in the EFED's general effort to reevaluate terrestrial arthropod residue assumptions. This information had been previously discarded by EPA because much of it involved insecticide treatments and insect trapping techniques considered by the EFED to be biased to collect only the low end of the possible distribution of insect residues.

Half-life insects: EFED assumed a uniform distribution based on Willis McDowell (1987) values of 1.1 to 8.8 days in plants and assumed insect residues would correlate strongly to plant residue fate parameters.

Fraction of bat diet that is treated with 2,4-D choline: Given a general lack of information related to the proportion of diet actually consumed by bats foraging over agriculture, EFED used information on the relative use of these areas compared to other land cover and the Recovery Plan conclusions of agricultural habitat uses as a reasonable surrogate for proportion of daily diet originating from agricultural fields. Based on the information summarized in the biology and habitat discussion earlier in this document, EFED assumed a triangular distribution of habitat use with a maximum based on the 67% agricultural land use suggested by the Recovery Plan and a minimum of 1% reflecting a situation where a bat is highly associated with non-agricultural land and a most likely value of 33% which is roughly the mean of the extremes of the distribution and is quite close to the findings of Sparks et al. (2005). This triangular distribution conservatively establishes that each of the 117,500 individual bats run through the model will have some agricultural habitat contributing to the daily prey base.

Food Ingestion: The daily food ingestion rate was scaled to individual bat bodyweight based on the screening calculations employed in the discussion of screening refinements earlier in this Indiana bat analysis.

Fixed Assumptions in the Model

Metabolized energy in bat prey: EFED used data from USEPA (1993) which established energy content in insects for two insect types: grasshopper/crickets (1.7 kcal/g fresh weight) and beetles (1.5 kcal/g fresh weight) to establish an opportunistic bat feeding average energy content of 1.6 kcal/g fresh weight). This value was modified by a fixed assumption of assimilation efficiency 0f 0.87 (USEPA 1993) to derive a metabolized energy content by the equation: 1.6*0.87= metabolized energy= 1.392 kcal/g fresh weight.

Rat clearance of pesticide: Because the refined toxicity data are expressed as repeated external oral dose and any accumulation potential within the test organism is automatically accounted for using this approach, no factor for day to day clearance of pesticide within the exposed organisms is expressly considered.

Application rate of pesticide: The model assumes a single pesticide application at the labeled maximum rate and all 117, 500 potentially exposed bats are assumed to get some prey from a treated field receiving this maximum application rate.

Crystal Ball Results (117,500 trials, random seed)

The Crystal Ball model was run under the above described conditions and a report was generated for the proportion of all bats modeled where one or more days of exposure would result in exposure at or above 55 mg/kg/day (Appendix 4). The results indicate that no bat experiences even one day of oral exposure meeting or exceeding the refined toxicological threshold.

Final Analyses of All Lines of Evidence and Determination

EFED has established a complete exposure pathway for Indiana bats to 2,4-D choline when bats are foraging over treated fields. The types of bat prey can include taxa that are likely associated with crop areas. The bats have been observed to forage over agricultural fields and residues are expected in invertebrate prey base originating from these fields. The standard screening risk assessment, not accounting for variability of prey base, body weights, but mindful of bat intake rates on an energy basis predicted concern for reproduction effects. However, this screening approach does not account for 2,4-D rapid elimination from both the exposed organism and the prey base, nor does it establish a complete picture of the expected duration of exposure necessary to elicit reproduction/developmental effects. A more refined understanding of the pharmacokinetics of 2,4-D and associated observations of reproduction and developmental effects suggests that a more accurate toxicity threshold is appropriate for a refined risk assessment. Probabilistic assessment, accounting for the number of female bats in the potentially exposed population, their variable body weight, intake rate, and forage frequency over agriculture, coupled with residue variability and a more refined effect threshold, indicates that daily exposures will not meet or exceed levels of toxicological concern for reproduction and development.

With this enhanced understanding of the fate and effects of 2,4-D, and the biology, population size, and habitat use of the Indiana bat, **EFED concludes a "no effect" determination for this species.**

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Appendix 1
List of Species for Which Risk Concerns Were Identified at the Screening Level

List of Species

American Burying Beetle (*Nicrophorus americanus*)
Black-footed Ferret (*Mustela nigripes*)
Canada Lynx (*Lynx canadensis*)
Purple Cat's Paw (*Epioblasma obliquata obliquata*)
Clubshell (*Pleurobema clava*)
Northern Copperbelly Watersnake (*Nerodia erythrogaster neglecta*)
Decurrent False Aster (*Boltonia decurrens*)
Pitcher's Thistle (*Cirsium pitcheri*)
Dwarf Lake Iris (*Iris lacustris*)
Eastern Prairie White-fringed Orchid (*Platanthera leucophaea*)
Fanshell (*Cyprogenia stegaria*)
Fassett's Locoweed (*Oxytropis campestris var. chartacea*)
Fat Pocketbook Pearlymussel (*Potamilus capax*)
Gray Bat (*Myotis grisescens*)
Higgins Eye Pearlymussel (*Lampsilis higginsii*)
Hine's Emerald Dragonfly (*Somatochlora hineana*)
Illinois Cave Amphipod (*Gammarus acherondytes*)
Indiana Myotis (*Myotis sodalis*)
Karner Blue Butterfly (*Lycaeides melissa samuelis*)
Kirtland's Warbler (*Dendroica kirtlandii*)
Lakeside Daisy (*Hymenoxys acaulis var. glabra*)
Leafy Prairie-Clover (*Dalea foliosa*)
Least Tern (*Sterna antillarum*)
Mead's Milkweed (*Asclepias meadii*)
Mitchell's Satyr Butterfly (*Neonympha mitchellii mitchellii*)
Northern Riffleshell (*Epioblasma torulosa rangiana*)
Northern Wild Monkshood (*Aconitum novoboarense*)
Orangefoot Pimpleback (*Plethobasus cooperianus*)
Pallid Sturgeon (*Scaphirhynchus albus*)
Pink Mucket (*Lampsilis orbiculata*)
Piping Plover (Great Lakes DPS) (*Charadrius melodus*)
Piping Plover (Northern Great Plains DPS) (*Charadrius melodus*)
Pleistocene Disc (*Discus macclintocki*)
Prairie Bushclover (*Lespedeza leptostachya*)
Price's Potato Bean (*Apios priceana*)
Rabbitsfoot (*Quadrula cylindrica cylindrica*)

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Rayed Bean (*Vilosa fabalis*)
Running Buffalo Clover (*Trifolium stoloniferum*)
Scaleshell Mussel (*Leptodea leptodon*)
Scioto Madtom (*Noturus trautmani*)
Sheepnose Mussel (*Plethobasus cyphyus*)
Short's Goldenrod (*Solidago shortii*)
Small Whorled Pogonia (*Isotria medeoloides*)
Snuffbox Mussel (*Epioblasma triquetra*)
Spectaclecase Mussel (*Cumberlandia monodonta*)
Topeka Shiner (*Notropis topeka (=tristis)*)
Virginia Spiraea (*Spiraea virginiana*)
Western Prairie White-fringed Orchid (*Platanthera praeclara*)
White Catspaw (*Epioblasma obliquata perobliqua*)
Whooping Crane (*Grus americana*)
Winged Mapleleaf Mussel (*Quadrula fragosa*)
Rough Pigtoe (*Pleurobema plenum*)
Tubercled Blossom (*Epioblasma torulosa torulosa*)

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Appendix 2

Listed Species Rationale for NO Effects When Action Area is Limited to Treated Agricultural Filed by Assumed Mitigation for Spray Drift

Species Name	Habitat Description	Reason for Exclusion	References
Black-footed Ferret (*Mustela nigripes*)	The black-footed ferret relies on prairie dog colonies for both food and shelter (FWS, 2008, p 8).	The proposed 2,4-D choline salt uses are not expected to overlap with prairie dog colonies.	USFWS. 2008. 5-Year Review. http://ecos.fws.gov/docs/five_year_review/doc2364.pdf
Purple Cat's Paw (*Epioblasma obliquata obliquata*)	Historically distributed throughout the Ohio River basin, the purple cat's paw was known only from the Green River in Kentucky and the Cumberland River in Tennessee (US FWS, 1992, p. 2). A reproducing population was also found in Killibuck Creek in Ohio, but due to recent degradation of Killibuck Creek, it may no longer be viable (FWS, 2010, p 3-4). The purple cat's paw is characterized as a large-river species inhabiting water of shallow to moderate depth and with moderate to swift currents. It has been reported from boulder and sand substrates (US FWS, 1992, p. 1-2).	The proposed 2,4-D choline salt uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1992. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/920310.pdf USFWS. 2010. 5-Year Review. http://ecos.fws.gov/docs/five_year_review/doc3316.29.10.pdf
Clubshell (*Pleurobema clava*)	Clubshell is generally found in clean, coarse sand and gravel in runs, often just downstream of a riffle, and cannot tolerate mud or slackwater conditions (USFWS, 1994).	The proposed 2,4-D choline salt uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1994. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/940921.pdf

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Northern Copperbelly Watersnake (*Nerodia erythrogaster neglecta*)	Copperbellies are generally affiliated with wetlands and prefer shallow wetlands, such as shrub-scrub wetlands dominated by buttonbush (*Cephalanthus occidentalis*), emergent wetlands, or the margins of palustrine open water wetlands. Buttonbush swamps are used as basking areas. Areas frequented by copperbellies generally have an open canopy, shallow water, and short dense vegetation. Uplands are also important. (US FWS, 2008, p. 17-18). The snake is only listed north of 40 degrees (US FWS, 1997).	The proposed 2,4-D choline salt uses are not expected to overlap with wetlands, uplands, or other habitat that would be used by the northern copper belly watersnake.	USFWS. 1997. Federal Register Notice. http://ecos.fws.gov/docs/federal_register/fr3043.pdf USFWS. 2008. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/081223.pdf
Decurrent False Aster (*Boltonia decurrens*)	The natural habitat of the aster was the shores of lakes and the banks of streams including the Illinois River. It appears to require abundant light. It presently grows in such habitats but is more common in disturbed lowland areas where it appears to be dependent on human activity for survival (US FWS, 1990, p. 3). It occupies unimpounded floodplain habitats along the Illinois River system; the plant relies on periodic flood pulses to maintain populations and suitable habitat (US FWS, 2012, p. 7).	The proposed 2,4-D choline salt uses are not expected to overlap with the shores of lakes/streams or other floodplain habitats where the aster may occur.	USFWS. 1990. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/900928c.pdf USFWS. 2012. 5-Year-Review. http://ecos.fws.gov/docs/five_year_review/doc4044.pdf

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Pitcher's Thistle (*Cirsium pitcheri*)	It occurs on non-forested sand dunes of several types (grassland dunes, simple linear beach foredunes, continuous and discontinuous dune complexes), sand beaches, and sandy blowouts, primarily occurring around the Great Lakes (US FWS, 2002, p. 23-27).	The proposed 2,4-D choline salt uses are not expected to overlap with sand dunes, sand beaches, or sandy blowouts.	USFWS. 2002. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/020920b.pdf
Dwarf Lake Iris (*Iris lacustris*)	The dwarf lake iris grows along the northern shorelines of lakes Michigan and Huron in Wisconsin, Michigan and Ontario, Canada. It typically occurs in shallow soil over moist calcareous sands, gravel and beach rubble. Sunlight is one of the most critical factors to the growth and reproduction of the species and partly shaded or sheltered forest edges are optimal for sexual reproduction. Some form of disturbance is also required to maintain the forest openings that provide these partial shade conditions. The species is most often associated with shoreline coniferous forests dominated by northern white cedar and balsam fir. The principal limiting factor for dwarf lake iris is the availability of this suitable shoreline habitat (US FWS, 2013, pp. 6-7).	The proposed 2,4-D choline salt uses are not expected to overlap with shoreline coniferous forests.	USFWS. 2013. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/ DLI%20RP%20FINAL%20AUG2013_1.pdf
Eastern Prairie White-fringed Orchid	The eastern prairie fringed orchid occurs in a wide variety of	The proposed 2,4-D choline salt uses are not expected to	USFWS. 1999. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/990929.pdf

(*Platanthera leucophaea*)	habitats, from mesic prairie to wetland communities such as sedge meadows, marsh edges and even fens and sphagnum bogs. It requires full sunlight for optimum growth and flowering, which restricts it to grass- and sedge-dominated plant communities. The substrate of the sites where it occurs ranges from more or less neutral to mildly calcareous, typically glacial soils. It is often early successional, but can be maintained in mid- to late successional wetlands that remain open and sunny (US FWS, 1999, pp. 6-7).	overlap with grass or sedge-dominated plant communities.	
Fanshell (*Cyprogenia stegaria*)	The fanshell inhabits gravel substrates in medium to large rivers of the Ohio River basin (US FWS, 1991, unpaginated Executive Summary).	The proposed 2,4-D choline salt uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1991. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/910709.pdf
Fassett's Locoweed (*Oxytropis campestris var. chartacea*)	Fassett's locoweed grows along the shorelines of small, landlocked, hardwater lakes where the bedrock is overlain by sandy glacial drift. Nearly all lakes with historical populations of the species are less than 15 ha in size and occur at approximately 350 m elevation. Dependent upon groundwater seepage for their water supply, most are shallow (maximum depth of a few meters) and subject to frequent,	The proposed 2,4-D choline salt uses are not expected to overlap with the shorelines of lakes.	USFWS. 1991. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/910329.pdf

	large fluctuations in water level. Fassett's locoweed is found along the lakes on open shoreline and, to a lesser extent, on higher ground under the partial shade of adjacent vegetation. I t grows on gentle, sandgravel slopes and is absent from flat, low, mucky shorelines dominated by cattails and bulrushes. Because of periodic fluctuations in lake levels, the amount of exposed, open shoreline varies, from being virtually nonexistent during times of high water, to about 30 m wide when the water level is low. In all cases, Fassett's locoweed occurs in areas which are completely exposed to sunlight or receive only partial shade from other species. (US FWS, 1991, pp.4-5).		
Fat Pocketbook pearlymussel (*Potamilus capax*)	The fat pocketbook is a large river species requiring flowing water and a stable substrate, which can vary widely but is most likely a mixture of sand, silt and clay. It occurs in water from a few inches deep to at least 8 feet. Habitat includes drainage ditches. (US FWS, 1989, p. 6). Populations have been found in larger rivers in the Ohio River system, and it may occur as deep as	The proposed 2,4-D choline salt uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1989. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/891114c.pdf USFWS. 2012. 5-Year Review. http://ecos.fws.gov/docs/five_year_review/doc3984.pdf

	20 feet (US FWS, 2012, p. 7-8). It can also tolerate periods of high suspended sediments (US FWS, 2012, p. 11).		
Gray Bat (*Myotis grisescens*)	Gray bats are year round cave dwellers, although they may also use mines. They hibernate from as late as November 10 to late March or early April. At other times, they forage from late afternoon through early morning within 12-20 miles of their caves, most often within 4 miles of their caves. Foraging habitat is strongly correlated with open waters (rivers, lakes, reservoirs) (US FWS, 2009, pp. 6-7). Historically, rivers near caves provided both foraging habitat and riparian tree vegetation that provided cover. Small lakes and reservoirs where cover is not too distant also provide foraging habitat. Bats will opportunistically forage in riparian and upland areas, particularly when migrating (US FWS, 1982. pp. 6-7).	The proposed 2,4-D choline salt uses are not expected to encompass caves or the forest/open water areas where bats forage.	USFWS. 1982. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/820701.pdf USFWS. 2009. 5-Year Review. http://ecos.fws.gov/docs/five_year_review/doc2625.pdf
Higgins Eye Pearlymussel (*Lampsilis higginsii*)	The higgins eye pearlymussel is characterized as an inhabitant of large rivers with loose substrates and low velocities. Many of the largest populations are in the Mississippi River, and all are in its upper drainage (US	The proposed 2,4-D choline salt uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2004. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/040714.pdf

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	FWS, 2004, p. 7-8).		
Hine's Emerald Dragonfly (*Somatochlora hineana*)	The hine's emerald dragonfly occupies grass marshes and sedge meadows fed primarily by water from a mineral source or fens. Two important characteristics of the habitat appear to be groundwater-fed, shallow water slowly flowing through vegetation, and underlying dolomitic or limestone bedrock. Parts of the aquatic channels are typically covered by vegetation such as cattails or sedges. Soils can range from organic muck to mineral soils like marl. Two other important components are areas of open vegetation for foraging and forests, trees or shrubs that provide shaded areas for perching or roosting. Nearby adjacent forests may be deciduous (Illinois) or conifer (Wisconsin and Michigan). Larvae are usually found in small flowing streamlets within cattail marshes, sedge meadows, and hummocks. Places with silt, leaf litter, and decaying grasses as a substrate are often used (US FWS, 2001, p. 15-16.). Critical Habitat of 26,531 acres have been designated in Michigan, Illinois,	The proposed 2,4-D choline salt uses are not expected to overlap with grass marshes, sedge meadows, forested areas, or other habitat where the Hine's emerald dragonfly is expected to be found.	USFWS. 2001. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/010927.pdf

	Wisconsin, and Missouri. Almost half of this is Mackinac County, MI.		
Illinois Cave Amphipod (*Gammarus acherondytes*)	The Illinois cave amphipod occurs in streams in dark areas of limestone caves which have many sinkhole openings and which underlay primarily cultivated fields, along with forests and urban areas (US FWS, 2002, p. 4). Within the caves, the amphipod is found primarily in riffles over a gravel substrate in both mainstream and tributary reaches. They are found most often in shallow waters less than 4 inches deep, but may occur as deep as 16 inches (US FWS, 2002, p.10).	The proposed 2,4-D choline salt uses are not expected to overlap with caves.	USFWS. 2002. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/020920.pdf
Karner Blue Butterfly (*Lycaeides melissa samuelis*)	Habitat is successional areas with wild lupines, such as open areas in and near forest stands, along with old fields, highway and powerline rights-of-way, and remnant barrens and savannas, having a broken or scattered tree or tall shrub canopy(US FWS, 2003. pp.28-30)	The proposed 2,4-D choline salt uses are not expected to overlap with successional areas with lupines or other wildflowers.	USFWS. 2003. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/030919.pdf
Kirtland's Warbler (*Dendroica kirtlandii*)	Kirtland's warblers generally occupy jack pine stands that are 5-23 years old and at least 30 acres in size. Stands with less than 20% canopy over are rarely used for nesting. Occupied stands usually occur	The proposed 2,4-D choline salt uses are not expected to overlap with jack pine stands.	USFWS. 2012. 5-Year Review. http://ecos.fws.gov/docs/five_year_review/doc4045.pdf

	on dry, excessively drained and nutrient poor glacial outwash sands. They are structurally homogenous with trees ranging from 1.7-5.0 m in height (US FWS, 2012, p. 24). Species is migratory and mobile species and breeding areas are found in Wisconsin.		
Lakeside Daisy (*Hymenoxys acaulis var. glabra*)	Although historical habitats include outcrops of dolomite or limestone bedrock, dry, gravelly prairies on terraces or hills associated with major river systems, rocky shores, sandy fields and alvars, the Lakeside daisy in the U. S. is now restricted to dry, thin-soiled, degraded prairies in which limestone or dolomite bedrock is at or near the surface. Habitats are alkaline, seasonally wet in spring and fall, and are moderately to extremely droughty in summer. Typically, habitats have little topographic relief, are relatively open at the ground surface, and vegetation density and diversity are relatively low. Within these habitats, lakeside daisy occurs in open patches of ground, occupies the dry to mesic portions of the soil moisture continuum and has a highly aggregated distribution. This species is either	The proposed 2,4-D choline salt uses are not expected to overlap with quarries and dry prairies.	USFWS. 1990. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/900919b.pdf

	absent or infrequently found in shaded or densely vegetated areas (US FWS, 1990, pp. 20-21).		
Leafy Prairie-Clover (*Dalea foliosa*)	Leafy prairie-clover is found only in open limestone cedar glades, limestone barrens, and dolomite prairies which have shallow, silt to silty clay loam soils over flat and often highly fractured, horizontally bedded limestone or dolomite with frequent expanses of exposed bedrock at surface. Elevations are typically between 550 and 700 feet. These habitats experience high surface and soil temperatures, generally have low soil moisture but are wet in the spring and fall and become droughty in summer. The distribution of glade, barren, and dry to wet dolomite prairie at any particular site varies and leads to a mosaic of soils and their associated plant communities (USFWS, 1996, p.13).	The proposed 2,4-D choline salt uses are not expected to overlap with prairies or areas with visible bedrock.	USFWS. 1996. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/900919b.pdf
Least Tern (*Sterna antillarum*)	Species is a piscivore, feeding in shallow waters of rivers, streams (USFWS, 1990, p. 20). Beaches, sand pits, sandbars, islands and peninsulas are the principal breeding habitats of coastal areas and nesting can be close to water but is usually between the dune environment	The proposed 2,4-D choline salt uses are not expected to overlap with riparian areas, including coastal areas.	USFWS. 1990. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/900919a.pdf

	and the high tide line. Vegetation at coastal nesting areas is sparse, scattered and short. Riverine nesting areas are sparsely vegetated sand and gravel bars within a wide unobstructed river channel, or salt flats along lake shorelines. Nesting occurs along river banks (US FWS, 1990, p. 20).		
Mead's Milkweed (*Asclepias meadii*)	Mead's milkweed occurs primarily in tallgrass prairie with a late successional bunch-grass structure, but also occurs in hay meadows and in thin soil glades or barrens. This plant is essentially restricted to sites that have never been plowed and only lightly grazed, and hay meadows that are cropped annually for hay (US FWS, 2003, p. 9).	The proposed 2,4-D choline salt uses are not expected to overlap with tallgrass prairies, hay meadows, or thing soil glades or barrens.	USFWS. 2003. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/030922b.pdf
Mitchell's Satyr Butterfly (*Neonympha mitchellii mitchellii*)	Mitchell's satyr is typically an inhabitant of limestone/calcareous fens, typically northern wetlands fed by nutrients from upslope sources and groundwater. Known habitats of the Mitchell's satyr are all peatlands, but they range along a continuum from prairie/bog fen to sedge meadow/swamp. All historical and active habitats have an herbaceous community which is dominated by sedges, usually *Carex stricta*,	The proposed 2,4-D choline salt uses are not expected to overlap with wetlands.	USFWS. 1998. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/980402.pdf

	with scattered deciduous and/or coniferous trees, most larch or red cedar. Fens often contain a mosaic of wetland habitat types, with their associated vegetation. Occasionally the larch or cedar component is replaced by dense shrubs. This satyr is often found at the interface of sedge wetlands and the taller components of its environment. The host plant for the larval stage is almost certainly a *Carex sedge*, but the species is not known; several may be involved (US FWS, 1998, pp.11-12.).		
Northern Riffleshell (*Epioblasma torulosa rangiana*)	The habitat of the riffleshell occurs in packed sand and gravel in riffles and runs, and also in the western basin of Lake Erie where there is sufficient wave action to produce continuously moving water (US FWS, 1994, p. 18). FWS further describes the habitat as medium to large rivers where they are often associated with high water velocities, although they have also been documented in Lake Erie and in deep more slow-flowing rivers down to 20 feet (US FWS, 2009. p. 9).	The proposed 2,4-D choline salt uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2009. 5-Year Review. http://ecos.fws.gov/docs/five_year_review/doc3284.pdf
Northern Wild Monkshood (*Aconitum novoboarense*)	Typical habitat is shaded to partially shaded cliffs and talus slopes or in	The proposed 2,4-D choline salt uses are not expected to overlap with	USFWS. 1983. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/830923.pdf

	New York, also occurs in semi-shaded seepage springs at high elevation headwaters. Various bedrock types from sandstones to dolomite and others act as substrates. All habitats have a cold soil environment associated with active and continuous cold air drainage or cold ground water flowage out of the nearby bedrock. Typically cliff and talus slope populations are associated with openings or caves, often ice-filled, through which the cold air emanates (US FWS, 1983, p. 18-20).	cliffsides, rockfalls at cliff bases or springs associated with cold air or water.	
Orangefoot Pimpleback (*Plethobasus cooperianus*)	The 1984 Recovery Plan indicated that the orange-foot pimpleback was known from the Tennessee, Cumberland, and lower Ohio Rivers (US FWS, 1984. p. 2). The habitat is described as medium to large rivers in sand and gravel substrates. In the Ohio River it was collected from 15-29 feet depths, but may have lived in shallower riffles (US FWS, 1984, p. 6).	The proposed 2,4-D choline salt uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840930b.pdf
Pallid Sturgeon (*Scaphirhynchus albus*)	Habitat is the bottom in swift waters of large, turbid, free-flowing rivers, often over sand substrates, but other substrates include at least gravel and rock. Sloughs, chutes, and side channels that	The proposed 2,4-D choline salt uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1993. Draft Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/Pallid%20Sturgeon%20Draft%20Revised%20Recovery%20final%20draft%2003%2004%202013%20for%20web%20publication.pdf USFWS. 2007. 5-Year Review. http://ecos.fws.gov/docs/five_year_review/doc1059.pdf

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	transition from floodplain to the main channels are apparently important as spawning, nursery, and feeding areas. Within the subject states, this habitat occurs in the Mississippi and Missouri rivers (US FWS, 1993, pp 6-7). Within this habitat, they tend to select main channel habitats in the Mississippi River, and main channel habitats with islands or sand bars in the upper Missouri River (US FWS, 2007. p. 8). They do not typically occur in impounded areas due to lower flows and other hydrologic factors, nor where channel stabilization has reduced channel meandering and access to floodplain areas (US FWS, 2007, p. 38).		
Pink Mucket (*Lampsilis orbiculata*)	The pink mucket may still exist in stretches of the lower Ohio River (US FWS, 1985, p. 10). The pink mucket habitat is large rivers at least 60 feet wide, where it occurs at depths up to 25 feet deep. Currents are typically moderate to fast and substrates range from silt to boulders, rubble, gravel, and sand (US FWS, 1985, p. 11). The species seems to have adapted to living in impounded waters, at least in the upper reaches where the	The proposed 2,4-D choline salt uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1985. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/pink%20mucket%20rp.pdf

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	water is flowing (US FWS, 1985, p. 10).		
Piping Plover (Great Lakes DPS) (*Charadrius melodus*)	The breeding habitat of the Great Lakes DPS of the piping plover is well defined by the Critical Habitat designation. Critical Habitat for this DPS consists of approximately 200 miles of Great Lakes shoreline (extending 1640 ft inland) in 26 counties in Minnesota, Wisconsin, Michigan, Illinois, Indiana, Ohio, Pennsylvania, and New York. Additional Critical Habitat for wintering populations of this DPS are in the southeastern United States and other areas that are outside the scope of this analysis (USFWS, 2000; USFWS, 2009, p.2).	The proposed 2,4-D choline salt uses are not expected to overlap with sparsely vegetated sandy shorelines or islands of the Great Lakes.	USFWS. 2009. 5-Year Review. http://ecos.fws.gov/docs/five_year_review/doc3009.pdf USFWS. 2000. Federal Register Notice http://ecos.fws.gov/docs/federal_register/fr3648.pdf
Piping Plover (Northern Great Plains DPS) (*Charadrius melodus*)	The northern Great Plains DPS of the piping plover utilizes four types of habitats for breeding: alkali lakes and wetlands, inland lakes (Lake of the Woods), reservoirs, and rivers. Most breeding occurs along alkali lakes and wetlands, where nesting sites are generally wide, gravelly, salt encrusted beaches with minimal vegetation . At inland lakes, they use barren to sparsely vegetated islands, beaches, and peninsulas. Sparsely vegetated sandbars and reservoir	The proposed 2,4-D choline salt uses are not expected to overlap with shorelines, beaches, and sandbars of rivers and alkali wetlands.	USFWS. 2002. Federal Register Notice. http://ecos.fws.gov/docs/federal_register/fr3943.pdf

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	shorelines are preferred in riverine systems (US FWS, 2002, p. 57640).		
Pleistocene Disc (*Discus macclintocki*)	The Iowa Pleistocene snail only occurs on high quality algific (cold producing) talus slopes with temperatures ranging from 35-45 degrees Fahrenheit. Air flows through fractured bedrock, over frozen groundwater, and out-vents on steep slopes to create a cold microclimate. These are talus covered slopes with thin soil that makes them extremely fragile and sensitive to disturbance, and irreplaceable. This habitat is known only to occur in the "driftless area" that overlaps where the states of Illinois, Iowa, Minnesota, and Wisconsin come together (US FWS, 2009, p. 11). All known areas are north-facing slopes, and the ground temperature seldom exceeds 50 degrees Fahrenheit even in the hottest summers (US FWS, 1984, p. 5).	The proposed 2,4-D choline salt uses are not expected to overlap with algific talus slopes.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840322.pdf USFWS. 2009. 5-Year Review. http://ecos.fws.gov/docs/five_year_review/doc2585.pdf
Prairie Bushclover (*Lespedeza leptostachya*)	The prairie bush clover occurs on both undisturbed and disturbed sites over sandy, loam, or gravelly soils included at the thin margins near rock outcrops. Sites may have been previously mowed, burned or grazed (US FWS, 1988, p. 7-8).	The proposed 2,4-D choline salt uses are not expected to overlap with prairies.	USFWS. 1988. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/881006.pdf

Price's Potato Bean (*Apios priceana*)	Found in open forests along the edges of forests, creeks, and rivers (US FWS, 1993, p. executive summary).	The proposed 2,4-D choline salt uses are not expected to overlap with forests, or water bodies.	USFWS. 1993. Recovery Plan http://ecos.fws.gov/docs/recovery_plan/930210.pdf
Rabbitsfoot (*Quadrula cylindrica cylindrica*)	"Rabbits foot is primarily an inhabitant of small to medium sized streams and some larger rivers. It usually occurs in shallow water areas along the bank and adjacent runs and shoals with reduced water velocity." They have been reported in deep water runs up to 12 feet depth. "Bottom substrates generally include gravel and sand" (US FWS, 2012, p. 63446).	The proposed 2,4-D choline salt uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2012. Federal Register Notice. http://www.gpo.gov/fdsys/pkg/FR-2012-10-16/pdf/2012-24151.pdf
Rayed Bean (*Vilosa fabalis*)	The rayed bean is generally known from smaller, headwater creeks, but occurrence records exist from larger rivers. They are usually found in or near shoal or riffle areas, and in the shallow, wave-washed areas of glacial lakes, including Lake Erie. In Lake Erie, the species is generally associated with islands in the western portion of the lake. Preferred substrates typically include gravel and sand and often include vegetation, where they may be buried among roots (US FWS, 2012, p. 8633).	The proposed 2,4-D choline salt uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2012. Federal Register Notice. http://www.gpo.gov/fdsys/pkg/FR-2012-02-14/pdf/2012-2940.pdf
Running Buffalo Clover (*Trifolium*	Running buffalo clover occurs in mesic habitats of	The proposed 2,4-D choline salt uses are not expected to	USFWS. 2007. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/070627.pdf

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stoloniferum)	partial to filtered sunlight, where there is a prolonged pattern of moderate periodic disturbance, such as mowing, trampling, or grazing. It is most often found in regions underlain with limestone or other calcareous bedrock. Specific habitats include mesic woodlands, savannahs, floodplains, stream banks, sandbars, grazed woodlots, mowed paths (e.g. cemeteries, parks), old logging roads, jeep trails, ATV trails, skid trails, mowed wildlife openings within mature forest, and steep ravines. It has been suggested that the original habitat may have been open woods or savannah, and bison herbivory on associated species may have kept the habitats open (US FWS, 2007, p. 12.).	overlap with mesic habitats where the clover is expected to be found.	
Scaleshell mussel (*Leptodea leptodon*)	The scaleshell habitat is composed of riffles and runs in medium to large rivers with low to medium gradients and slow to moderate velocity of current. It inhabits a variety of substrates from gravel to mud, but riffles are primarily stable (US FWS, 2010, p.18).	The proposed 2,4-D choline salt uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2010. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/100407_v2.pdf
Scioto Madtom (*Noturus trautmani*)	Only 18 individuals have were ever collected, all found along one stretch of Big Darby Creek in Ohio (US FWS, 2009, p. 4). The	The proposed 2,4-D choline salt uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2009. 5-Year Review http://ecos.fws.gov/docs/five_year_review/doc3057.pdf

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	scioto madtom prefers stream riffles of moderate current over gravel bottoms with high quality water that is free of suspended sediments. The riffle habitat where the 18 individual were collected was comprised of glacial cobble, gravel, sand, and silt substrate with some large boulders (US FWS, 2009, p. 5).		
Sheepnose mussel (*Plethobasus cyphyus*)	The sheepnose is a larger-stream species occurring primarily in shallow shoal habitats with moderate to swift currents over coarse sand and gravel. Habitats with sheepnose may also have mud, cobble, and boulders. Sheepnose in larger rivers may occur at depths exceeding 6 m (US FWS, 2012, p 14916).	The proposed 2,4-D choline salt uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2012. Federal Register Notice. http://www.gpo.gov/fdsys/pkg/FR-2012-03-13/pdf/2012-5603.pdf
Short's Goldenrod (*Solidago shortii*)	The habitat of Short's goldenrod is open areas in full sun or partial shade. Known occurrences are in limestone cedar glades, open eroded areas, edges, of open oak-hickory woods, cedar thickets, pastures, old fields, power line rights-of-way and rock ledges along rights-of-way. Cedar glades and woodland edges appear to be the natural habitat. Short's goldenrod was known historically and currently only from Kentucky when the Recovery Plan	The proposed 2,4-D choline salt uses are not expected to overlap with glades, woodland edges, pastures, or other habitat favorable for goldenrod growth.	USFWS. 1988. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/shortsgrodRP.pdf USFWS. 2007. 5-Year Review. http://ecos.fws.gov/docs/five_year_review/doc1609.pdf

	was written in 1988 (US FWS, pp. 3-4). An Indiana occurrence was located in 2001 along the Blue River in riparian habitat (US FWS, 2007, p. 6).		
Small Whorled Pogonia (*Isotria medeoloides*)	The small whorled pogonia occurs on upland sites in mixed-deciduous or mixed deciduous/coniferous forests that are generally in second- or third-growth successional stages. It occurs on both fairly young and maturing forest stands. Most occurrences include sparse to moderate ground cover in the species' microhabitat, a relatively open understory canopy, and proximity to features that create long persisting breaks in the forest canopy. Soils at most sites are highly acidic and nutrient poor, with moderately high soil moisture values. Light availability could be a limiting factor for this species. The one Illinois site is unusual in being on a dry, steep, thinly forested slope atop a vertical sandstone bluff. The one Ohio site is along the Ohio River in a typical Appalachian-type forest association (US FWS, 1992, pp. 23-24).	The proposed 2,4-D choline salt uses are not expected to overlap with mixed deciduous/coniferous forests.	USFWS. 1992. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/921113b.pdf
Snuffbox Mussel (*Epioblasma triquetra*)	The habitat is described as swift currents and riffles, and shoals and wave-washed shores of	The proposed 2,4-D choline salt uses are not expected to overlap with rivers, streams, creeks, or	USFWS. 2012. Federal Register Notice. http://www.gpo.gov/fdsys/pkg/FR-2012-02-14/pdf/2012-2940.pdf

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	lakes over gravel and sand with occasional cobble and boulders. They generally burrow deep into the substrate (US FWS, 2010, p 67554). This constitutes a wide diversity of habitats. However, they do not occur in impounded areas or reservoirs (except tailwaters) (US FWS, 2012, p 8652).	other water bodies.	
Spectaclecase Mussel (*Cumberlandia monodonta*)	The spectaclecase generally inhabits large rivers where it occurs in microhabitats sheltered from the main force of current. It occurs in a variety of substrates from mud and sand to gravel, cobble, and boulders in relatively shallow riffles and shoals with a slow to swift current. It is most often found in firm mud between large rocks in quiet water very near the interface with swift currents (US FWS, 2012, p 14916).	The proposed 2,4-D choline salt uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2012. Federal Register Notice. http://www.gpo.gov/fdsys/pkg/FR-2012-03-13/pdf/2012-5603.pdf
Topeka Shiner (*Notropis topeka (=tristis)*)	Topeka shiners are typically found in small, low order, prairie streams with good water quality, relatively cool temperatures, and low fish diversity. Although Topeka shiners can tolerate a range of water temperatures, cooler, spring-maintained systems are considered optimal. These streams generally maintain perennial flow but may become	The proposed 2,4-D choline salt uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2004. Federal Register Notice. http://ecos.fws.gov/docs/federal_register/fr4300.pdf

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	intermittent during summer or periods of drought, as long as there are refuge areas in headwaters springs or main channels of larger streams that do not provide adequate year-round habitat. While headwaters, oxbows and side channels provide the typical habitat, mainstem streams provide for dispersal as well as for drought refuge. The shiner is very often associated with groundwater discharges. Substrates are typically clean gravel, cobble, or sand, but may include bedrock and clay hardpan covered by a thin layer of silt, or coarse sand overlain by silt and detritus. Spawning is often over native sunfish nests (US FWS, 2004, pp,44743-4).		
Virginia Spiraea (*Spiraea virginiana*)	*Spiraea virginiana* is found along the banks of high gradient sections of second and third order streams, or on meander scrolls and point bars, natural levees, and other braided features of lower reaches (often near the stream mouth). The habitat is in oft-disturbed early successional areas. Occasional flood scouring reduces shading and seems to be essential, although the spiraea can tolerate some overstory growth (US FWS, 1992, pp.17-	The proposed 2,4-D choline salt uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1992. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/921113a.pdf

	18.).		
Western Prairie White-fringed Orchid (*Platanthera praeclara*)	The western prairie-fringed orchid occurs primarily in tall grass prairies dominated by bluestem grass and in sedge meadows that are seasonally wet (US FWS, 1996, p. 6). They also may occur in successional communities such as borrow pits, old fields, and roadside ditches (US FWS, 1996, p. 4).	The proposed 2,4-D choline salt uses are not expected to overlap with prairie, meadow areas, roadside ditches, borrow pits or abandoned fields.	USFWS. 1996. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/960930a.pdf
White Catspaw (*Epioblasma obliquata perobliqua*)	The white cat's paw pearly mussel is currently known to exist in only a 3-mile portion of Fish Creek in Williams County in northwest Ohio. Museum records indicate that it historically occurred in Indiana in the Wabash, White, Tippecanoe, Maumee, and St. Joseph rivers, and Ohio in the Maumee and St. Joseph Rivers and Fish Creek. It was last observed in 1999 (US FWS, 2009, p. 7). The Recovery Plan indicates that the habitat is unclear but appears to be riffle run reaches of small to moderately large rivers (US FWS, 1990, p. 16).	The proposed 2,4-D choline salt uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1990. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/900125.pdf USFWS. 2009. 5-Year Review. http://ecos.fws.gov/docs/five_year_review/doc3058.pdf
Winged Mapleleaf Mussel (*Quadrula fragosa*)	The general habitat is poorly known, although it has been characterized as a large stream species. It has been collected on mud, mud-covered gravel, and gravel substrates. In its current location in the St. Croix River, it	The proposed 2,4-D choline salt uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1997. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/970625.pdf

	occurs in riffles with clean gravel, sand, or rubbles substrates and fast current. It was not found in a natural impoundment of the river (US FWS, 1997, p. 5-6).		
Rough Pigtoe (*Pleurobema plenum*)	The rough pigtoe habitat is medium to large rivers, 60 feet or wider, in sand and gravel substrates. Very limited collection information suggests it occurs below spillways, in transition zones, and in sand and gravel substrates (US FWS, 1984, p. 8).	The proposed 2,4-D choline salt uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840806.pdf
Tubercled Blossom (*Epioblasma torulosa torulosa*)	Although most large river habitat for this species has been drastically altered, it is possible the species survives in a remnant habitat patch, which could still exist in the lowermost 50 miles of the Ohio River. Based on the size of the river, "if the species continues to exist, it may do so at virtually undetectable levels". FWS considered, therefore, "that the tubercled blossom should remain an endangered species" (US FWS, 2011, p 7).	The proposed 2,4-D choline salt uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2011. 5-Year Review. http://ecos.fws.gov/docs/five_year_review/doc3781.%20torulosa.pdf

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Appendix 3
Expected Application Periods for 2,4-D choline
Based on Planting date and Stage information

Enlist Brand of 2,4-D Corn and Soybean Information

FROM Bill Chism, Bill Phillips, Sunil Ratnayake (Biological and Economic Assessment Division) February 4, 2014

The timing on the label for 2,4-D Enlist in corn and soybean are as follows.

- Corn
  - Pre-plant – Postemergence V8 stage (or 30 inches) - 31 to 38 days after planting (SDSU reference)
  - Preharvest up until 30 days prior to forage harvest
- Soybean
  - Pre-plant – Postemergence no later than R2 (full flower) - 46 days after planting (NDSU reference)
  - Preharvest up until 30 days prior to harvest

Soybean usual planting and harvest dates by state

		Planting Dates			Harvest Dates		
State	2009 Harvested acres (1,000 acres)	Begin	Most active	End	Begin	Most active	End
Alabama	430	Apr 15	May 25 - Jun 25	Jul 3	Sep 3	Oct 28 - Nov 28	Dec 15
Arkansas	3,270	Apr 19	May 5 - Jun 22	Jul 5	Sep 10	Sep 29 - Nov 13	Nov 26
Delaware	183	May 11	May 30 - Jun 28	Jul 11	Oct 5	Oct 22 - Nov 14	Nov 25
Florida	34	Apr 20	May 1 - Jun 15	Jul 1	Oct 1	Oct 15 - Nov 25	Dec 1
Georgia	440	May 5	May 17 - Jun 26	Jul 5	Oct 11	Oct 25 - Dec 8	Dec 17
Illinois	9,350	May 2	May 8 - Jun 12	Jun 24	Sep 19	Sep 26 - Oct 26	Nov 7

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Indiana	5,440	May 1	May 5 - Jun 10	Jun 25	Sep 20	Oct 1 - Nov 1	Nov 10
Iowa	9,530	May 2	May 8 - Jun 2	Jun 16	Sep 21	Sep 28 - Oct 20	Oct 31
Kansas	3,650	May 5	May 15 - Jun 20	Jul 1	Sep 20	Oct 1 - Nov 1	Nov 15
Kentucky	1,420	May 4	May 16 - Jun 27	Jul 7	Sep 25	Oct 10 - Nov 14	Nov 25
Louisiana	940	Apr 18	Apr 23 - Jun 4	Jun 16	Aug 28	Sep 3 - Oct 25	Oct 31
Maryland	475	May 11	May 28 - Jun 26	Jul 16	Oct 5	Oct 18 - Nov 15	Dec 1
Michigan	1,990	May 2	May 11 - Jun 9	Jun 18	Sep 25	Oct 3 - Nov 3	Nov 13
Minnesota	7,120	May 2	May 8 - Jun 2	Jun 13	Sep 20	Sep 27 - Oct 20	Oct 31
Mississippi	2,030	Apr 19	Apr 26 - May 31	Jun 17	Sep 10	Sep 13 - Oct 31	Nov 9
Missouri	5,300	May 2	May 13 - Jun 24	Jul 4	Sep 25	Oct 3 - Nov 8	Nov 23
Nebraska	4,760	May 5	May 11 - May 31	Jun 8	Sep 23	Sep 29 - Oct 24	Nov 2
New Jersey	87	May 10	May 20 - Jul 1	Jul 10	Oct 1	Oct 20 - Nov 10	Nov 15
New York	254	May 12	May 19 - Jun 22	Jun 29	Sep 27	Oct 7 - Nov 14	Nov 20
North Carolina	1,750	May 1	May 20 - Jun 30	Jul 20	Oct 10	Nov 10 - Dec 5	Dec 20
North Dakota	3,870	May 7	May 14 - Jun 3	Jun 11	Sep 17	Sep 24 - Oct 21	Nov 5
Ohio	4,530	Apr 26	May 3 - May 30	Jun 10	Sep 23	Sep 30 - Oct 31	Nov 12
Oklahoma	390	Apr 15	Apr 27 - Jun 27	Jul 9	Sep 9	Sep 22 - Nov 20	Dec 1
Pennsylvania	445	May 10	May 20 - Jun 10	Jul 5	Oct 5	Oct 20 - Nov 10	Nov 30
South Carolina	565	May 10	May 27 - Jun 27	Jul 11	Oct 20	Nov 10 - Dec 10	Dec 30
South Dakota	4,190	May 8	May 15 - Jun 11	Jun 21	Sep 22	Sep 28 - Oct 24	Nov 3
Tennessee	1,530	May 5	May 15 - Jun 25	Jul 5	Sep 25	Oct 5 - Nov 20	Nov 30
Texas	190	Mar 24	Mar 30 - May 30	Jun 12	Aug 18	Aug 22 - Oct 17	Nov 7
Virginia	570	May 5	May 15 - Jul 3	Jul 9	Oct 4	Oct 16 - Nov 28	Dec 4
West Virginia	19	May 5	May 10 - Jun 30	Jul 5	Sep 25	Oct 5 - Nov 30	Dec 1
Wisconsin	1,620	May 7	May 12 - Jun 5	Jun 14	Sep 29	Oct 4 - Oct 29	Nov 8

Field Crops Usual Planting and Harvesting Dates (October 2010) USDA, National Agricultural Statistics Service

Corn for Grain Usual Planting and Harvesting Dates – States

		Planting Dates			Harvest Dates		
State	2009 Harvested acres (1,000 acres)	Begin	Most active	End	Begin	Most active	End
Alabama	250	Mar 15	Mar 25 - Apr 25	May 18	Aug 2	Aug 11 - Sep 20	Oct 15
Arizona	20	Mar 10	Apr 1 - May 15	Jun 1	Sep 1	Oct 1 - Nov 1	Dec 1
Arkansas	410	Mar 26	Apr 1 - Apr 26	May 9	Aug 16	Aug 23 - Sep 23	Oct 6
California	160	Mar 15	Apr 1 - Jul 1	Jul 15	Sep 1	Oct 1 - Nov 1	Nov 15

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Colorado	990	Apr 19	Apr 28 - May 20	May 29	Sep 28	Oct 8 - Nov 13	Nov 22
Delaware	163	Apr 12	Apr 30 - May 16	May 28	Sep 10	Sep 20 - Oct 15	Nov 5
Florida	37	Mar 1	Mar 15 - Apr 25	May 5	Jul 15	Aug 1 - Sept 10	Oct 1
Georgia	370	Mar 14	Mar 22 - Apr 21	May 4	Aug 6	Aug 16 - Sep 22	Oct 7
Idaho	80	Apr 21	May 5 - May 26	Jun 9	Sep 29	Oct 20 - Nov 10	Nov 24
Illinois	11,800	Apr 14	Apr 21 - May 23	Jun 5	Sep 14	Sep 23 - Nov 5	Nov 20
Indiana	5,460	Apr 20	May 1 - Jun 1	Jun 10	Sep 15	Oct 1 - Nov 10	Nov 25
Iowa	13,400	Apr 19	Apr 25 - May 18	May 26	Sep 21	Oct 5 - Nov 9	Nov 21
Kansas	3,860	Apr 5	Apr 15 - May 15	May 25	Sep 1	Sep 10 - Oct 25	Nov 10
Kentucky	1,150	Apr 6	Apr 14 - May 24	Jun 8	Sep 1	Sep 9 - Oct 24	Nov 10
Louisiana	610	Mar 13	Mar 19 - Apr 8	Apr 16	Jul 31	Aug 9 - Sep 5	Sep 12
Maryland	425	Apr 20	Apr 30 - May 20	Jun 7	Sep 9	Sep 22 - Oct 22	Nov 17
Michigan	2,090	Apr 21	May 1 - May 27	Jun 6	Sep 5	Oct 10 - Nov 25	Dec 10
Minnesota	7,150	Apr 22	Apr 26 - May 19	May 29	Sep 27	Oct 8 - Nov 8	Nov 23
Mississippi	695	Mar 17	Mar 24 - Apr 27	May 4	Aug 11	Aug 23 - Sep 23	Oct 7
Missouri	2,920	Apr 3	Apr 11 - May 27	Jun 12	Aug 29	Sep 8 - Nov 3	Dec 22
Montana	26	Apr 26	May 4 - May 28	Jun 4	Oct 4	Oct 25 - Dec 3	Dec 8
Nebraska	8,850	Apr 19	Apr 27 - May 15	May 21	Sep 18	Oct 4 - Nov 10	Nov 20
New Jersey	70	Apr 15	May 1 - May 20	Jun 15	Sep 25	Oct 10 - Nov 1	Nov 15
New Mexico	50	Apr 15	Apr 20 - May 10	May 20	Sep 25	Oct 1 - Oct 30	Nov 20
New York	595	Apr 20	May 4 - Jun 13	Jun 20	Oct 7	Oct 14 - Nov 14	Nov 25
North Carolina	800	Apr 1	Apr 10 - Apr 25	May 15	Aug 25	Sep 10 - Oct 10	Nov 1
North Dakota	1,740	Apr 26	May 2 - May 28	Jun 4	Sep 28	Oct 8 - Nov 19	Dec 6
Ohio	3,140	Apr 18	Apr 24 - May 24	May 30	Sep 27	Oct 11 - Nov 20	Dec 1
Oklahoma	320	Mar 21	Apr 2 - May 8	May 17	Aug 20	Aug 29 - Oct 9	Oct 20
Oregon	32	Mar 25	Apr 25 - Jun 5	Jun 15	Oct 10	Oct 20 - Nov 20	Dec 5
Pennsylvania	920	Apr 30	May 10 - May 25	Jun 15	Sep 25	Oct 15 - Nov 20	Dec 10
South Carolina	320	Mar 10	Mar 20 - Apr 20	May 15	Jul 25	Aug 20 - Sep 25	Oct 10
South Dakota	4,680	Apr 26	May 2 - May 27	Jun 10	Sep 24	Oct 6 - Nov 16	Dec 3
Tennessee	590	Apr 1	Apr 5 - May 10	May 25	Aug 25	Sep 1 - Oct 10	Oct 30
Texas	1,960	Mar 1	Mar 8 - May 7	May 17	Jul 18	Aug 1 - Oct 11	Nov 8
Utah	17	Apr 15	Apr 30 - May 20	Jun 5	Sep 25	Oct 10 - Oct 30	Dec 10
Virginia	330	Apr 5	Apr 11 - May 20	May 29	Aug 31	Sep 6 - Oct 28	Nov 9
Washington	105	Apr 10	Apr 20 - May 20	Jun 1	Sep 25	Oct 5 - Nov 15	Nov 25
West Virginia	30	Apr 20	May 1 - Jun 5	Jun 20	Sep 15	Sep 30 - Nov 20	Dec 1
Wisconsin	2,930	Apr 26	May 2 - May 27	Jun 4	Oct 2	Oct 14 - Nov 17	Nov 28
Wyoming	45	Apr 24	May 3 - May 21	Jun 6	Oct 5	Oct 18 - Nov 24	Dec 10

Field Crops Usual Planting and Harvesting Dates (October 2010) USDA, National Agricultural Statistics Service

REFERENCES

USDA 2010. Field Crops Usual Planting and Harvesting Dates October 2010 Available online at: http://usda01.library.cornell.edu/usda/current/planting/planting-10-29-2010.pdf

ED_Vaughn3_0003331

South Dakota State Univ. Corn growth stages with estimated calendar days and growing-degree units Available online at http://www.sdstate.edu/ps/extension/crop-mgmt/corn/upload/Corn-growth-stage-day-and-GDU-calendar10.pdf

North Dakota State Univ. Soybean Production Field Guide for North Dakota and Northwestern Minnesota. Avaiable online at http://www.ag.ndsu.edu/pubs/plantsci/rowcrops/a1172.pdf

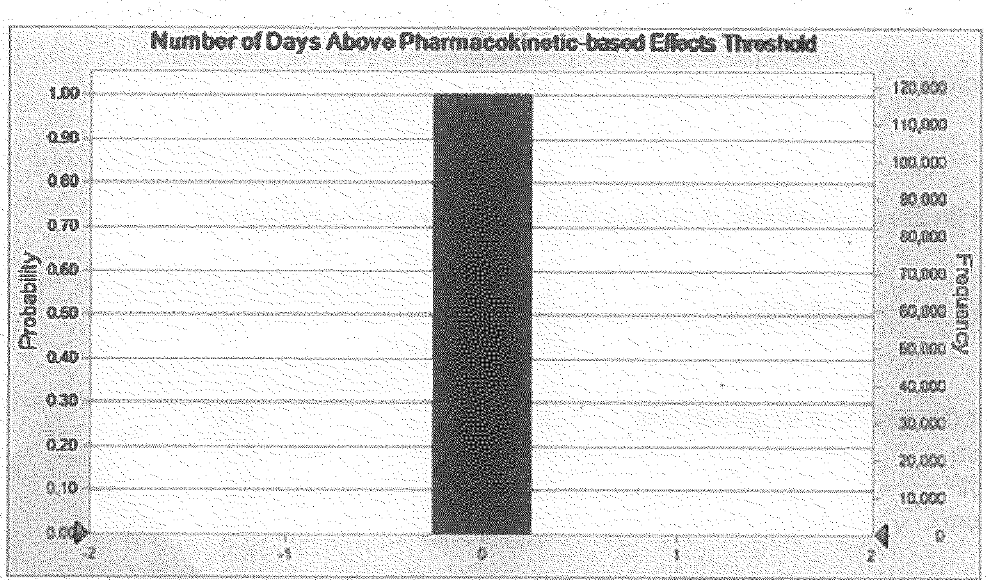
ED_Vaughn3_0003332

Appendix 4
Crystal Ball Report

Forecasts

Forecast: Number of Days Above Pharmacokinetic-based Effects Threshold **Cell: B184**

Summary:
Entire range is from 0.00 to 0.00
Base case is 0.00
After 117,500 trials, the std. error of the mean is 0.00



Statistics:	Forecast values
Trials	117,500
Base Case	0.00
Mean	0.00
Median	0.00
Mode	0.00
Standard Deviation	0.00
Variance	0.00
Skewness	---
Kurtosis	---
Coeff. of Variation	---
Minimum	0.00
Maximum	0.00

Range Width	0.00
Mean Std. Error	0.00

Forecast: Number of Days Above Pharmacokinetic-based Effects Threshold (cont'd) **Cell: B184**

Percentiles:	Forecast values
99.9991%	0.00
99.9992%	0.00
99.9993%	0.00
99.9994%	0.00
99.9995%	0.00
99.9996%	0.00
99.9997%	0.00
99.9998%	0.00
99.9999%	0.00
100%	0.00

End of Forecasts

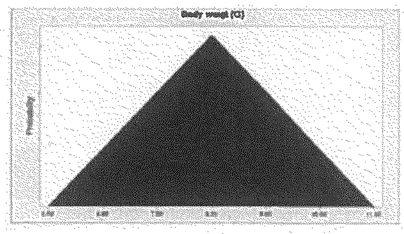
Assumptions

Worksheet: [Indianna Bat PRA_2_5-14_3 22 pm (Autosaved).xlsx]Sheet1

Assumption: Body weigt (G) **Cell: B24**

Triangular distribution with parameters:

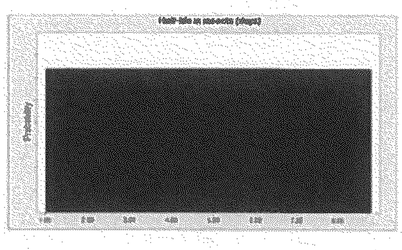
Minimum	5.00
Likeliest	8.00
Maximum	11.00



Assumption: Half-life in insects (days) **Cell: B13**

Uniform distribution with parameters:

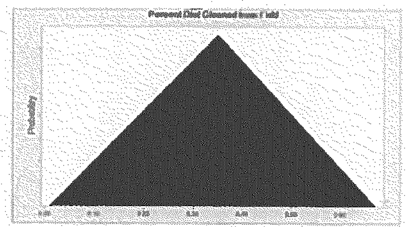
Minimum	1.00
Maximum	8.80



Assumption: Percent Diet Gleaned from Field **Cell: B28**

Triangular distribution with parameters:

Minimum	0.01
Likeliest	0.35
Maximum	0.67

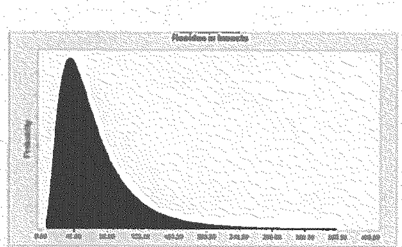


Assumption: Residue in Insects **Cell: B18**

Lognormal distribution with parameters:

Location	0.00	
Mean	65.00	(=B16)
Std. Dev.	48.00	(=B17)

Assumption: Residue in Insects (cont'd) **Cell: B18**



End of Assumptions